

Malayan Trombiculid Mites

2. Naked-eye observations on attached chiggers, with a simple checklist of Malayan species, and details of preferred hosts

By J. R. AUDY¹

Institute for Medical Research, Kuala Lumpur

(Received September, 1955)

THE OBJECT of this paper is to summarize the naked-eye appearance, favourite hosts, and favourite sites of attachment of the 83 species of trombiculid mites so far collected in Malaya by the Colonial Office Research Unit. These observations were incidentally made during the course of a general survey of animals and their parasites² as potential reservoirs and vectors of infections involving man. The collections, mostly from Selangor, have been described elsewhere (Audy & Harrison, 1954). Since 1948, over 21,000 animals have been searched and their ectoparasites mounted or preserved, mostly by M. Nadchatram and Lee Fatt-Hing, but also by Johann bin Haji Adam and Phang Ong-Wah. The routine identification of the trombiculids has been the responsibility of Nadchatram. Other collections have been made, mostly in Borneo, jointly by U.S. Army workers (led by Robert Traub) and members of this Unit (see Traub & Audy, 1954) but these are not considered here.

The opportunity is here taken of listing all the species so far found in Malaya, confirmed new species being shown by the first three letters of their manuscript names or a reference number. Some seven additional forms, probably new species but requiring further study, are excluded. The basis for the taxonomic arrangement is that of the checklist in Wharton & Fuller (1952), with slight modifications as discussed by Audy (1954, 1955*abc*) plus the introduction of the genera *Babiania* and *Schoutedenichia* and the subgenera *Helenicula* and *Laurentella*, since described.

The characters discussed here are those which can be seen by the naked eye of an observer familiar with chiggers, aided occasionally by a hand-lens ($\times 10$ to $\times 25$).

Naked-eye appearances

General appearance.—The parasitic trombiculid larvae or chiggers range in size from minute specks (0.15 mm.) to fairly large swollen bodies of 1.5 mm., varying greatly according to species and the degree of engorgement. They attach to their hosts in various favoured sites, discussed below, scattered about singly or in small groups, or in closely-packed colonies, or sometimes both scattered and in colonies, according to species of chigger, species of host, and intensity of infestation. They are numerous, some animals regularly supporting an average of nearly 100 per individual, while there may be many thousands attached to even a small animal. Larvae of some groups are generally very small, such as most Gahrlepiines and the subgenera *Walchiella*, *Trombicula* sens. str. and *Laurentella*; others are large, such as the *Euschöngastia lacunosa* group, *Blankaartia*, and *Whartonia*. Certain chiggers appear to become grossly engorged, being

¹. Assisted by M. Nadchatram, Senior Laboratory Assistant, and Lee Fatt-Hing, Laboratory Assistant, in the Division of Virus Research and Medical Zoology.

². These investigations have been largely financed by Colonial Development and Welfare funds (Research Schemes R177 *et seq.*, originally for Scrub Typhus research).

almost helpless when detached, and becoming distorted when mounted, often with the scutum folded or inverted at the anterior fold of the body which overlaps the mouth-parts; such chiggers are *Euschöngastia lipoxena*, the intranasal species of *Doloiisia*, and *Trombicula vorca* (the last being found in Borneo, not Malaya). Certain species or groups show a transverse constriction or "waist" when engorged—e.g. many *Gahrlepieia* (especially *Walchia*), *Doloiisia*, *Laurentella*, and *T.(T.)"NOR"*. Otherwise, most species are ovoid, though a few are subglobular such as *T. hastata*, *T. consueta*, *T. keukenschrijveri*, *E. lipoxena* and some *Walchiella*. A few species are found to present a peculiar desiccated or shrivelled appearance, flattened and translucent, when attached to certain less-favoured sites: this has been repeatedly observed with *Gahrlepieia fletcheri* and *T. keukenschrijveri* when attached to the edges or the outside of the host's ears. Within the ear and also elsewhere on the body even on the same host, the mites appear normal, while those outside the ears appear dead and are most difficult to detach. The larvae of *T. dimolineae* from the ear of a bat appeared so shrivelled and dead. The surfaces of the engorged larvae of some species may show such recognizable characters under the hand-lens as:—

- (a) large dense scuta in the *G. ornata* group;
- (b) a peculiar dimpling presumably due to the depression of sites of muscular attachment or retraction of suspended organs within, as is so commonly seen in the post-larval stages, although the dimpling is more punctate in the nymphs and more shallow in the larvae; such dimpling is best seen in the detached engorged larvae, and is for example easily visible in *Siseca subrara* (but not in *S. rara*), intranasal *Laurentella* ("*TAA*" and "*TBB*" but not "*LAU*"), and it particularly contrasts with other species (*Blank. acuscutellaris*, *E. (W.) oudemansi*) whose cuticle always appears to be tensely inflated;
- (c) the cuticular striae, occasionally well-developed as in all *Walchiella*;
- (d) the body setae, which show up particularly well by suitable lighting and probably give the most dependable information; these setae may be prominent because of unusual numbers (cf. the series *T. deliensis*, *T. akamushi*, *T. keukenschrijveri* with DS counts of 28, 36, 50), or unusual development such as length (*E. "THOM"*; *T. pipellae* from Borneo), plumosity (*T. keukenschrijveri*), or other modification (e.g. the more bizarre *Trombiculindus* species of India).

Colour.—The colour of chiggers ranges from a translucent near-white or off-white to bright scarlet. In the tabulation which follows, near-white larvae are described as *pallid*. The colour usually pales with increasing engorgement. Taken as a whole, the Malayan species are pallid, yellow or pink tinted, or orange to red coloured, in roughly equal proportions, but when the commoner species are considered, pallid species are relatively few, most being yellowish or pink to light orange, while a few are relatively strongly coloured. The same species may vary considerably in colour (e.g. *E. (W.) oudemansi*, *E. (L.) indica?*, see below) but we have in several cases found colour differences to assist in the detection of distinct but similar species, e.g. *T. deliensis* (coloured) and *T. "LAN"* (pallid), *E. (L.) indica* (pallid) and *E. (L.) audyi* (coloured), *Siseca rara* (coloured) and *S. subrara* (pale). An orange-coloured form of *E. indica* found in the forest is currently being investigated for possible morphological differences (Audy 1956a).

Attachment to Hosts

The manner of attachment and feeding of chiggers on their hosts, with the formation of a stylostome or sucking-tube, has been described in detail by Jones (1950) and others. So also have local reactions to their bite (scrub-itch, trombidiasis), particularly by Parkhurst (1937), Nuñez (1947), and Siqueira (1949). The length of time for which they feed in situ has been studied particularly by Harrison (1954). All these features, together with the favoured sites of attachment on the host, have been summarized and discussed by Wharton & Fuller (1952:115). The following observations summarize findings in Malaya, with some references to conditions in India (Audy *et al.*, 1953).

The attachment of chiggers gregariously in closely-packed colonies or individually scattered is related partly to the habits of the species in relation to the particular host's skin, and partly to degree of infestation. With the heavier infestations, colonies may be formed in favoured places while the "overflow" may attach singly or in small groups elsewhere.

Reptiles.—The generally favoured sites of attachment on reptiles are in the axillae and wholly or partly under scales on the flanks and belly, around the throat, on the inner and outer sides of the thighs, and around the anus and base of the tail; occasionally, on the toes. Loveridge (1925) found clusters of chiggers (*Acomatacarus? gymnodactylus* (Ewing)) in deep soft-skinned axillary pockets of geckoes from India. These "mite-pockets", to which Loveridge gave the picturesque name of acarodomatia, were frequently found in African lizards and geckoes by Lawrence (1949:479), but they are not conspicuous in Malayan species in which the axillae are simple folds. The Varanids (monitor lizards) have axillary folds which can be described as pockets, but these appear to be favoured by ticks and not by chiggers, although *Eutrombicula wichmanni* has been found infesting the haunches. Chiggers on reptiles in Malaya are frequently found underneath the scales, producing tenting, though Southcott (1954) states that this is unusual in Australia; and while he has described (1947) chiggers as being usually present in the auditory canals of lizards, we have never found this site favoured in Malaya. It is obvious that a comparative study would be very interesting. The wing-expansions of flying-lizards in Malaya have yielded interesting species.

Birds.—In common with Lawrence's findings in South Africa we have found birds to be rarely infested by chiggers in Malaya (Audy, 1956b: 72, 78), the only exception being quail and rails, heavily infested by the vectors of scrub typhus, and domestic fowls infested by *E. (Eutrombicula) wichmanni* and *Neoschöngastia gallinarum*, mostly in mixed colonies in ulcers under the wings and among the feathers, especially in the flanks. In North Borneo, joint expeditions with the U.S. Army Unit have also found certain birds in certain localities to be freely infested, e.g. crow-pheasants with *T. wichmanni* and *T. vorca* (Traub & Audy, 1954:47).

Mammals.—The generally favoured site of attachment of chiggers to mammals is to the thin inner epithelium of the ear especially of rodents. The deeper part (concha) is divided into two fossae by a fold: the inner fossa is the most favoured site, and as this fills up, the adjacent outer fossa is selected. Closely packed colonies may easily be seen in these fossae. While chiggers may attach almost anywhere else on the body, specially favoured sites, presumably where the epithelium is thin and protected, are elsewhere on the pinnae of the ears, around the lips or muzzle, the folds (inguinal or axillary) of hind or fore legs, and around teats, genitalia, and anus. In addition certain chiggers favour

protected and permanently moist sites, such as *Ascoschöngastia malayensis* deep in the bony auditory canal of *Rattus canus*, *Euschöngastia oculicola* (Wom.) in the conjunctivae of rats in Ceylon, and various species, especially *Euschöngastia* and *Doloisia* (and in Africa, Gahrlepiines), deep in the intranasal cavities of rodents (Fig. 2), a habitat which is still being explored (Audy & Vercammen-Grandjean, 1955).

Some groups show special preferences for sites other than the inner conchae of the ears. The Gahrlepiines often favour the edges of the ears, the chin and lips (fig. 1), and occasionally the muzzle (vibrissae), inner thighs, and anal region. Intranasal species in Malaya are mostly confined to *Doloisia* (VN-group) and subgenus *Laurentella*, though Traub has recorded a *Leptotrombidium* from this habitat in Borneo (I.M.R., 1955). Traub & Morrow (1955:45) have described a hypodermal species, *Gahrlepieia* (G.) *penetrans*, which had burrowed completely into the perineal skin of *Rattus whiteheadi* in Borneo.

The same species frequently prefers different sites on different hosts, apart from the obvious differences between mammals and reptiles or birds, two or all three of which are frequently included in the host-range of *E. (Eutr.) wichmanni*, *S. rara*, *T. (L.) akamushi*, and *T. (L.) deliensis*. For example, the vector *T. deliensis* prefers the ear-fossae of rats or voles over the whole range of its distribution, but in Malaya it may also infest, for example, (a) the shrew-like erinaceid *Hylomys*, in colonies on the hairless rump, a relatively hairless patch on the belly, in the usual thin-skinned parts of the body (axillary and inguinal folds, inner thighs) and generally scattered about, but not all down the midline of the venter; (b) the larger tree-shrew *Tupaia glis*, in colonies in axillary and inguinal folds and along the midline of the venter; (c) shrews, *Crocidura*,

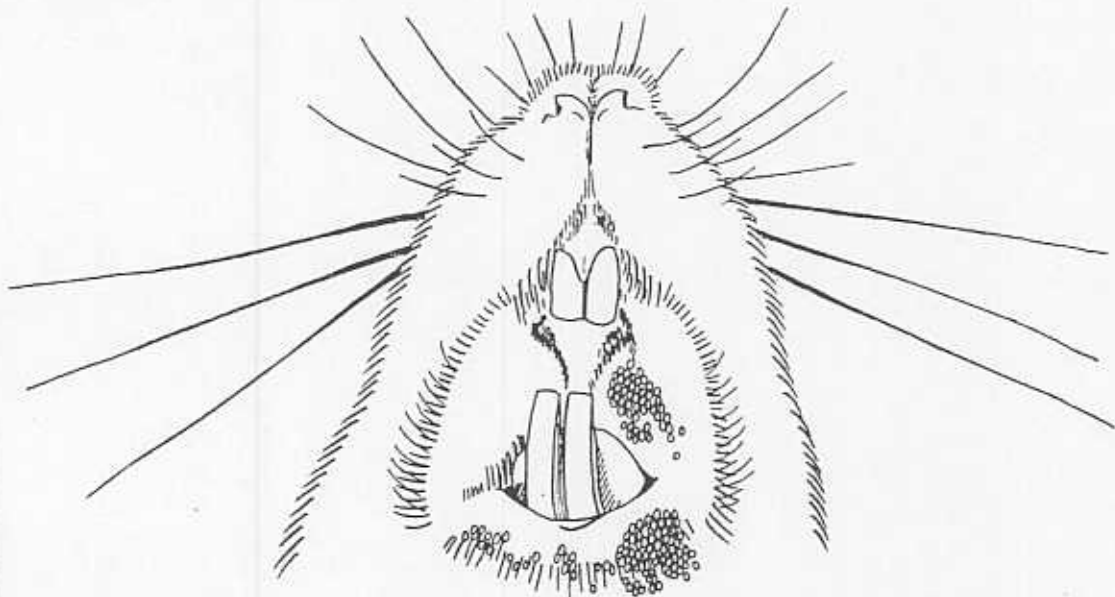


Fig. 1. Muzzle of *Rattus rattus jarak*, Jarak Island, 1949, with colonies of *Gahrlepieia* (Walchia) *rustica* (Gater) on chin and cheek-pads. *Trombicula deliensis* was present in large numbers in the ears. The same distribution was found with *Gahrlepieia* (G.) *fletcheri* (Gater) on rats in the Sembilan Islands, and *G. (W.) rustica* from rats on Berhala Island. These gahrlepiine chiggers are usually found on the ears of rats on the mainland.

in colonies on the rump, axillary and inguinal folds, hind legs, and also generally scattered. In Manipur, India, this chigger was very common on the belly and rump of *Tupaia glis belangeri*; and also on the belly, inguinal folds, inner thighs, genitals and anus of the common shrews, *Suncus murinus*, which we have rarely found to be infested in Malaya. Also in Manipur, thousands of chiggers of this species were found attached to macaque monkeys down the midline of the body and in orange-coloured rows along the eyebrows and edges of eyelids. In Malaya, rails and quail are often heavily infested on the breast, belly, and under the wings, but especially in a small area on the sternum in the midline. Similarly *Gahrlepieia fletcheri* is usually found within and along the edges of the ears of forest ground-rats and ground-squirrels, but on *Rattus rattus rumbia* on the Sembilan Islands it covered the chin as in fig. 1, as well as at the bases of the vibrissae; on *Tupaia glis* it prefers the venter and ears.

Tenacity of attachment.—Unfed or slightly engorged larvae are generally more difficult to detach artificially than engorged larvae, and larvae in colonies appear to be more readily detached than single ones or larvae in small groups. The tenacity of the same species may differ on different parts of the same host, probably being harder to detach from tougher skin; *T. keukenschrijveri* is noticeably harder to detach from the body

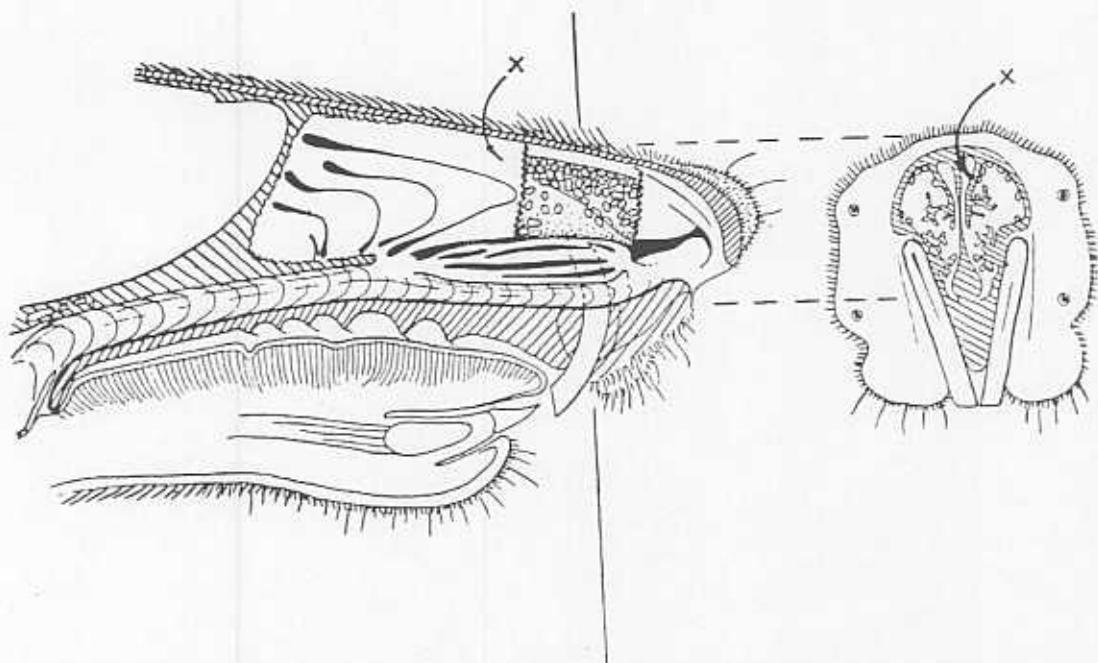


Fig. 2. Site of election for intranasal chiggers in *Rattus rajah* from forest in Selangor (semidiagrammatic). The septum has been removed and the left naso-turbinal (X) partly resected. Most of these chiggers would represent the *Dolaisia VN*-group (an average of 30 chiggers per rat, usually 2 or 3 species) and a few would be *Euschöngastia* (*Laurentella*) 'TAA' and 'TBB'. The naso-turbinals are much more developed than the maxillo-turbinals below them, and the site of election for intranasal chiggers in Malaysia appears to be the walls of the chamber lateral to the naso-turbinals, especially against the part of the nasal bone exposed in the diagram. This chamber may occasionally be choked by a hundred or more chiggers.

than it is from the ears. Possibly for similar reasons, the same species may vary on different hosts; *Eutr. wichmanni* is generally much more easily detached from domestic fowls than it is from rats.

Some species attach fairly lightly and may be readily detached without damage by means of a mounted bristle or needle; such species are most *Gahrlepiines*, *T. deliensis*, *Eusch. indica* and *E. oudemansi*. The intranasal species hardly appear to be attached to the nasal mucosa but it may be that they detach almost immediately on killing the host, though they do not emerge from the nose in significant numbers. *Ascoschöngastia malayensis* and *E. (L.) "CAN"* similarly lie about in the mucus of the auditory canal. Some species are attached so firmly that it is almost impossible to detach them without damage, in which case fragments of infested skin must be snipped off. Such are many species of bat-chiggers (e.g. *Whartonia* and subgenus *Trombicula*), and *Blankaartia acuscutellaris*. Most reptile-chiggers found in Malaya have been lightly attached (possibly because they are usually protected by the scales), but *Neoschöngastia riversi* was firmly attached to the wings of a flying-lizard. Associated with firm attachment there is often a tendency to bury the mouthparts or even the whole forepart of the larvae in the skin, some of the burying perhaps being due to reaction on the part of the host. *Whartonia* on the wings of bats is an example. It is doubtless this same tendency which leads through partial burying to the completely hypodermal habitat observed in the genus *Hannemania* (hypodermal in amphibia), some *Gahrlepiines* in Africa (e.g. new genus, Vercammen-Grandjean, in press) and the hypodermal *Gahrlepie* (*G.*) *penetrans* found by Traub in pits in the vulva of a rat in Borneo. Hypodermal chiggers have not so far been found in our Malayan collections.

Favourite hosts and host-specificity

Wharton (1946), Lawrence (1949), Wharton & Fuller (1952) and other observers have noted that the trombiculids generally show little or no host-specificity, but rather a varying degree of habitat-specificity. Our observations in Malaya have borne this out. Habitat-specificity may give an appearance of host-specificity, and occasionally it may not be possible to explain findings confidently by one explanation or the other. For example, it would now appear that the genera *Blankaartia* and *Healslipia* pertain particularly to water-birds or swamp-loving birds such as crow-pheasants, but in our collections in Malaya, based largely on mammals, these genera are each represented by one species which has been found only on *Rattus r. argentiventer* frequenting certain rice-growing areas where the fields are regularly flooded. It is therefore important to separate casual from principal hosts, and to refrain from drawing conclusions without extensive as well as intensive collection.

It is however now clear that (a) certain groups pertain particularly to reptiles (e.g. *Eutrombicula* sensu lato, including *Eltonella* Audy, and *Bablangia*; Audy, 1956b), or even to snakes only (*Fonsecia*), others to birds (*Neoschöngastia*), and others almost exclusively to mammals (subgenera *Leptotrombidium*, *Neotrombicula*, and *Trombicula*); and (b) certain groups specially closely related to their hosts in one way or another, show signs of developing true host-specificity in some of their members (e.g. *Ascoschöngastia* and *Laurentella*, see Audy, 1956a).

The following table shows the pattern of distribution on various hosts of those trombiculids in Malaya which occur in significant numbers. For the purposes of this paper, it is intended to guide the collector to the host of choice for the recovery of various species of chigger, and to serve as a provisional checklist.

A list of Malayan Trombiculid Mites with available data on naked-eye or hand-lens observations

Taxonomic arrangement as described on page 86. (N, A) signifies that Nymphs, Adults have been reared.

Characters: measurements in microns; unless otherwise stated, for partially engorged larvae. UL, PEL, EL=unfed, partially engorged, and engorged larvae, respectively.

Habitat etc: Only major hosts are noted here. Figures in parenthesis are the average number of chiggers per host for those species which occur at a rate of 1 or more per host.

Subfamily TROMBICULINÆ

Trombicula Berlese, subgenus *Trombicula*, *sensu stricto* after Audy 1954

- | | | |
|--|--|--|
| 1. <i>batui</i>
Philip & Traub, 1950 | Small, 330 × 190, elongate; pallid. | Pteropodid (<i>Eonycteris</i>) and Emballonurid (<i>Taphozous</i>) bats; local; occasional. Firmly attached undersurface wings. |
| 2. <i>dimolineae</i>
Audy, 1952 | 400 × 200, subovate, appeared shrivelled; yellowish. | Rhinolophid bat, firmly attached to inner side of edge of one ear. (Probably also to be found on wing membranes). |
| 3. <i>harrisoni</i>
Womersley, 1952 (N) | Very small, 300 × 200, broad, oval; pink. | Rhinolophid bats (<i>Hipposideros</i> , 1-2), commonest bat-chigger, scattered, firmly attached close to leading edge on outer face and along middle digit on inner face of wing, mixed with <i>Eusch. lipoxena</i> . |
| 4. <i>insolli</i>
Philip & Traub, 1950 | Small, 530 × 290, elongate; pallid. | Pteropodid (<i>Eonycteris</i>) and Emballonurid (<i>Taphozous</i>) bats; firmly attached, mixed with other spp., on wings. |
| 5. <i>munda</i>
Gater, 1932 (N) | Small, 300-410 × 210-290, elongate; pallid to light orange. | House-rats (<i>R.r. diardii</i>), and wood rat (<i>R.r. jalorensis</i>) in small numbers mixed with <i>E. indica</i> in ears. |
| 6. "NOR" (NA) | 350 × 200, subovate, slight transverse constriction; light orange to orange. | Tomb-bats (<i>Taphozous</i>) from forest; about 300 chiggers on 7 out of 7 bats, on outside of ears (easily overlooked unless the membranous ears are stretched); not firmly attached. |
| 7. <i>spicea</i>
Gater, 1932 (N) | Small 290-330 × 200-230, subovate; light yellow to orange. | Arboreal animals (<i>Callosciurus tenuis</i> , 3; <i>Tupaia glis</i> , 2; <i>Rattus canus</i> , 1), small numbers, scattered, with <i>Laurentella</i> spp. |
| 8. "PAR"—CORU. 25066 | cf. <i>T. dimolineae</i> | Rhinolophid bat (<i>Hipposideros</i>); 3 specimens on wing-membrane. |

Trombicula, subgenus Leptotrombidium Nagayo et al., sensu lato after Audy, 1954

9. *akamushi*
Brumpt, 1910 (NA)
UL 220 × 150, PEL 510 × 350, ELs 560 × 400, elongate subovate to subglobular, smooth, more hairy than *T. deliensis*; orange to dark orange; active, detach quickly, climb to ends of hairs, wander on bench freely.

Same as *T. akamushi* in all features except that the colour is generally less dark orange and that the slightly lesser hairiness is detectable with a hand-lens.

10. *deliensis*
Walch, 1922 (NA)
410–390, smaller than *T. deliensis*, sub-globular; pale orange to orange; many dorsal setae readily detectable with hand-lens—a point of difference from *T. akamushi*.

cf. *T. deliensis*, PEL 540 × 460; broad subovate, almost subglobular; pallid to yellowish; DS more conspicuous than those of *T. deliensis*, stronger and more plumose; not active, do not detach easily.

12. "LAN"
480 × 340, similar to *deliensis*; pallid.

13. *muridia*
Womersley, 1952 (N)

14. *sylvestris*
Audy & Traub, 1950 (N)
Large, EL 1,000 × 600, elongate oval, posterior and broad; pallid; coarse striation of body may be visible with hand-lens; clumsy and sluggish, tends to cling; not easily separable from *Eusch. lacunosa* but easily distinguished from other species.

Trombicula, subgenus Trombiculoides Radford, sensu lato

15. *hastata*
Gater, 1932 (N)
450 × 260–350, subglobular; pallid to light yellow.

(a) Field rat (*R.r. argentiventer*, 54) in grassland; in colonies in ears, also in colonies and scattered on edges and outside of ears, axillae and corresponding fold of hind legs; generally scattered with heavy infestations; often mixed with *deliensis*.

(b) Quail (and similar ground birds), in colonies and scattered under wings at wing-bend, axillae, folds of hindlegs, around anus, eyes, above beak, around neck, down sternum and midline of abdomen, on legs near foot. See also p. 89.

(a) Field rat (*R.r. argentiventer*, 19), or rats taking its place in grassy waste-land; also wood-rat (*R.r. jalorensis*) in plantations and forest-fringe; as for *akamushi*.

(b) Quail etc. as for *akamushi*. See also p. 89.

Giant-rats, and *R.r. jalorensis* and *Crocidura*, in forest. In small numbers mixed with other chiggers; may be grouped: *R. bowersi*, inside and outside ears; *R. mulleri*, inside ears; *R. sabanus*, anal region; *Crocidura*, hind legs, anal region; *R. rattus*, in ears. Easily detached only from inside ears, but this is difficult with those attached elsewhere, where the larvae also do not appear to engorge satisfactorily, appearing shrivelled (but still alive).

Giant-rats (*R. mulleri*, *R. bowersi*, 10–15) in forest: in colonies inside ears and on anal region, also scattered on edges of ears; mixed with other species, confused with *deliensis*.

Ground-squirrels (*Rhinosciurus* and *Lariscus*) and Giant-rats in forest. In small or moderate numbers, scattered, inside ears only, mixed with other chiggers.

Giant-rats (especially *R. sabanus*, and also *R. mulleri*) in forest, in moderate or small numbers, local (Ulu Langat F.R.), firmly attached, in small groups of 2–10, inside and outside ears, mixed with others.

Spiny-rat (*R. rajah*) in forest; occasional, scattered, in ears among other chiggers, local (esp. Sungai Buloh) or more in secondary forest.

Trombicula, subgenus *incertae sedis*, leveri-group of Audy 1953

16. *leveri* Womersley, 1952 EL 750 × 510, ovoid; colour unknown Emballonurid bat (*Emballonura*), taken once.
17. *revelae* Audy, 1952 340 × 300, broad oval; pink Rhinolophid bat (*Hipposideros*) from wings.

Trombicula, subgenus *incertae sedis*

18. *taphozous* Womersley, 1952 Large, 650 × 450, oval; pale orange or pink Emballonurid and Rhinolophid bats, occasional.
19. *consueta* Womersley, 1952 (N) 470 × 450, subglobular; light yellow to yellow Giant-rat (*R. bowersi*) in forest; rare, in ears, easily detached.

Eutrombicula, subgenus *Eutrombicula* Ewing

20. *wichmanni* Oudemans, 1905 (NA) Large, 600 × 410, oval to subpyriform; orange to light brown; UFLs extremely active and fast, ELs very sluggish, easily detached. Reptiles and birds: (a) Skinks (esp. *Mabuya*), in moderate numbers, scattered under scales on legs in axillae, and along flanks, often 2 chiggers under one scale, mixed with *T. rava* and *B. parvifera* under neighbouring scales. Rarely, under scales on flanks, belly, head, anus of snakes.
- (b) Domestic fowl, large numbers with *N. gallinarum*, in colonies on bottom of small punched-out ulcers with rolled-over edges, especially around upper leg and beneath tail.
- (c) occasionally on rats outside forest, especially *R. jalensis*, in ears.

Eutrombicula, subgenus *Eltonella* Audy, 1956 (this Journal, p. 32)

21. *eltoni* Audy, 1956 (N) = *fritisi*; Won. 1952 Very small, 230 × 180, subovate; pallid; inactive; easily detached. Common Giant Black-Scorpion (*Heterometrus*) in forest, closely but not in contact with each other, under sternites and pecten. Only once found mixed with the not-common large trombelline *Audysia thompsoni* (q.v.)
22. *tweediei* Audy, 1956 Small, 300 × 200 elongate; orange to bright orange; actively crawling when disturbed. Flying lizards (*Draco* spp.), lightly attached, scattered, ventral surfaces of "wings" (collected twice; once with *Neo. riverasi*).

Eutrombicula, subgenus *incertae sedis*, fieldi-group of Audy, 1956 (this Journal, p. 38)

23. *fieldi* Audy, 1956 370 × 250, elongate oval; light orange to orange; indistinguishable from *Bah. parvifera*. A skink, *Lygosoma*; under scales.

- Siseac Audy, 1956 (this Journal, p. 41)
24. *rara*
Walch, 1923 (N)
Small, 300×250 , subovate; bright orange to red; active.
25. *subrara*
Audy, 1956 (N)
Small, 320×240 , broad oval; light yellow to yellow; sluggish.
- Blankaartia Oudemans (= *Tragardhula* Bert)
26. *acutellaris*
Walch, 1922 (NA)
Large, UL 260×195 , PEL 600×420 subovate, wider posteriorly than *T. wichmanni*; bright scarlet (the brightest coloured chigger encountered in Malaya); ELs clumsy.
- Healslipia Ewing
27. *gateri*
Womersley & Healslip, 1943 (N)
Large, 690×395 subglobular.
- Babingia Southcott, *sensu lato*
28. *parmifera*
Womersley 1952 (N)
 330×240 , subovate; light orange to orange; fairly active.
29. *booliati*
Audy, 1956
 460×350 , subovate; light orange.
- Fonsecia Radford
30. *celesteae*
Audy, 1956
Large, 660×460 , broad, oval; yellow.
- Schöngastia Oudemans, *sensu stricto*
31. *vieta*
Gater, 1932 (N)
UL 230×220 , EL 490×350 , subovate; light orange to orange; active.
- Skins (*Mabuia*) in forest, lightly attached under scales on flanks, joints of legs, on legs, and on venter; small numbers, mixed with *T. wichmanni* and *Bab. parvifera*, under neighbouring scales. Occasionally in ears of squirrels, rats, tree-shrews.
- Giant pill-millipedes (*Sphaeropneustes*, 10) in forest (Bk. Lanjan F.R.); colonies on the membrane flanking the anus, and scattered on intersegmental membranes, laterally, between sternites. Fairly common: over 1,500 specimens on 57 out of 212 millipedes.
- Field-rats (*R.r. argentiventer*) in ricefields (local); moderate to large numbers, firmly attached in colonies inside and outside ears, usually accompanied by *T. deliensis* which may surround a colony of it. Related to swampy or flooded land, probably primarily on water-birds.
- Field-rat (*R.r. argentiventer*) from a rice-field area. Experiences in Africa by Vercammen-Grandjean suggest that this species is likely to pertain to water-birds, as with *Bl. acutellaris*.
- Skins (*Mabuia*) from forest; lightly attached in small groups or scattered, under scales on flanks, venter, legs; engorged larvae may protrude slightly from under the scale; mixed with *T. wichmanni* and *T. rara* but never under same scale.
- Skink (*Mabuia*) from forest; found once, scattered, lightly attached under scales of venter with *Bab. parvifera*, *T. wichmanni*, *T. rara*.
- Snake (*Natrix* sp.), collected only on one occasion, under scales along flanks. Also once on skink *Mabuia*.
- Giant-rat (*R. mulleri*) *R.r. jalorensis* in forest and forest fringe; (local (Sungei Buloh), in colonies and scattered, fairly small numbers and occasional, in ears.

Euschöngastia Ewing, subgenus *Helenicula* Audy

32. *mutabilis*
Gater, 1932 (N)

EL 390-570 × 230-340, elongate oval, with a slight constriction; orange to bright orange; active and easily disturbed.

Civet cats ('musangs') and rats near forest fringe, in small colonies and scattered, inside ears; mixed with other species; not uncommon.

Euschöngastia, subgenus *Laurentella* Audy (including *indica*-, *debilis*-, and TAA-groups of Audy, 1954, 1956)

33. *audyi*
Womersley, 1952 (NA)

Small, EL, 3— × 200, subovate; light orange to orange; fairly active.

Dominant chigger on arboreal (mammals) in forest (10-40), especially on squirrel *C. nigrovittatus*; in colonies in ears, often alone, may be mixed with e.g. *T. spicca*, *E. oudemansi*.

34. "CAN" (N)

Small, 320 × 240, subovate; pallid to light yellow.

Tree-rat (*Rattus canus*) from forest, as for *Asco. malayensis* (q.v.).

35. "CTEN"

Small, 300 × 220, subovate; light orange.

Tree-squirrel (*C. tenuis*) in forest; in small colonies in ears, mixed with *T. spicca*.

36. *debilis*
Gater, 1952

340 × 260, elongate oval; pallid.

Crocidura and water-shrew from forest, uncommon; scattered and occasional mixed with other species, in ears; rarely, on arboreal rat *R. cremoriventer*.

37. *indica*
Hirst, 1915 (NA)

Small, EL, 300 × 180, elongate oval; pallid to light yellow (form from forest-edge light orange to orange).

Common on House-rats (*R. r. diardii*, 10-20) and wood-rat *R. jalorensis* in oil palm plantation (30-40), in colonies in ears. A dominant, and usually the sole, chigger on house-rats in towns and villages over southeast Asia.

38. "LAU" (N)

320 × 230, subovate; light orange to dark orange.

Intranasal in tree-rat *R. cremoriventer* (3-4), in forest; possibly host-specific. See p. 90.

39. "TAA" (N)

Large, EL 1,100 × 690, broad oval, slight constriction; pallid to light orange.

Intranasal in spiny-rat *R. rajah* (1-5) in forest, scattered and in groups; mixed with *TBB* and *Doloisia* spp. See p. 90.

40. "TBB" (N)

Fairly large 690 × 500, broad oval, slight constriction; pallid to creamy.

Intranasal in *R. rajah* (30) in forest, as with TAA, with which it usually occurs. See p. 90.

Euschöngastia, subgenus *Walchiella* Fuller (this may warrant generic rank)

41. *oudemansi*
Walch, 1922 (N)

Small, 250 × 170, broad oval to sub-globular; smooth surface; pallid to orange (?); active and easily detached.

Common (10-30) on ground-living rodents in forest, especially giant-rats (*R. mülleri*, 25; *bowersi*, 19); also tree-rat *R. canus* (11); lightly attached, in colonies and scattered, inside and outside ears, to lips and chin, and around anus.

42. "FAT" (N)

Small, 230 × 185, broad oval to sub-globular; pallid to light yellow.

Tree-mouse *Chiropodomys*, found on only 3 out of 62 examined, inside ears.

43. *asonluca*
Traub & Audy, 1954 (N)

EL 400 × 320, broad oval; pallid to light yellow.

Gymnure *Hylomys* in forest; attached in colonies and scattered inside and outside ears, folds of fore and hind legs, and around anus (described from Borneo).

traubi
Womersley, 1952

UL 195 × 162, subglobular; as for *oudemansi*.

Giant-rat, (*R. subanai*), once; ? in ears.

Euschöngastia, subgenus incertae sedis, lacunosa-group of Audy, 1953 (?=Walchiella)

45. *lacunosa*
Gater, 1932 (N)
Large, 500-700 × 300-460, elongate oval with slight constriction; pallid to light yellow; colonies easily distinguished by size and grape-bunch-like appearance.
Indistinguishable from *E. lacunosa*
Giant rats (*R. sabanus*, 5; and *R. malleri*, 3) in forest; moderate numbers in colonies and scattered inside or outside ears, especially edges, indistinguishable from *E. nadchatrami*, and *T. sylvestris* but readily distinguished from other species; often alone, occasionally mixed with these species.
Giant-rat (*R. sabanus*) in forest; small numbers but not uncommon, scattered, inside and outside ears near edge; usually mixed with *E. lacunosa*.
46. *nadchatrami*
Womersley, 1952 (N)
Indistinguishable from *E. lacunosa*
- Euschöngastia, incertae sedis*
47. *lipoxena*
Womersley, 1952 (N)
Large, UL 300 × 250, EL 1,200 × 1,000, both UL & EL subglobular; pallid to creamy; appearance of EL more tick-like than chigger-like; sluggish.
48. "THON" (N)
EL 600 × 390, elongate oval; light yellow; the long whip-like DS may be visible under a lens, otherwise almost indistinguishable from *E. lacunosa*.
320 × 250, broad oval; pallid.
49. "BIS" (N)
Medium 420 × 280, subpyriform; pallid.
50. "SELL" (N)
- Ascoschöngastia* Ewing, *sensu stricto* (No. 51) & *Pseudoschöngastia* Lipovsky (No. 52)
51. *malayensis*
Gater 1932, (N)
Small, UL 180 × 130, EL 390 × 250, subovate, to subglobular slight constriction; pallid to slightly greenish yellow; sluggish, clumsy habit, reluctant to leave host.
Small, PEL 280 × 230, broad oval; light yellow.
52. "NOV"
- Neoschöngastia* Ewing
53. *gallinarum*
Hatori, 1920, (N)
390 × 320, subovate; pale orange to orange; active, wandering freely when disturbed.
350 × 200, elongate oval; yellow.
54. *riversi*
Wharton & Hardcastle, 1946
Domestic fowl (Kuala Lumpur), in moderate numbers; fairly lightly attached, small colonies in punched-out ulcers, in company with larger numbers of *T. wichmanni* (q.v.).
Flying lizards (*Draco*) from forest, collected twice only; scattered, firmly attached to lower surface of wing-membrane, mixed with *Trombicula tweediei*.

New Genus in MS = *Doloiisia* VN-group of Audy 1953

species:

55. "VERC" (N)
 56. "BRA" (N)
 57. "VARM" (N)
 58. "DOM" (N)
 59. "OWE" and others

Large, 640 × 500, broad oval, slight constriction; pallid to pale yellow.

Intranasal, especially in spiny rat *R. rajah* in forest (30) scattered and in groups deep in nasal cavities; commonest group of intranasal chiggers; occasionally found externally (e.g. in giant-rats from higher altitudes; *D. manipurensis* is from a rat's ears in India); mixed with species of *Laurentella* (q.v.). See p.

Note in press: Ten species are being described in *Malaysian Parasites XVI-XXXI*, 1957.

Schoutedenichia Jadin & Vercammen-Grandjean, 1954, *sensu lato*

60. *vercammeni* Audy, 1956

PEL 390 × 260, oval; pallid; single specimen.

Giant-rat (*R. sabanus*) in forest; inside ear; a fully engorged specimen might be difficult to distinguish from *lacunosa*-group.

Subfamily GAHLIEPIINÆ

Gahlripia Oudemans, subgenus Gahlripia (including *Gateria* Ewing), after Traub & Morrow, 1955

61. *cetrata*
 Gater, 1932 (N)

400 × 490 × 279 × 330, broad oval; pallid; sluggish.

62. *ciliata*
 Gater, 1932

380 × 260, oval; described from a single specimen, not encountered again since.

decora-group:

63. *decora*
 Womersley, 1952

64. *insigne*
 Womersley, 1952

65. *ornata*
 Womersley, 1952 (N)

66. *picta*
 Traub & Morrow, 1952

67. *tessellata*
 Traub & Morrow, 1952

Various ground-living hosts in forest (Giant-rats; *Tupaia glis*; *Groedira*; *Hylomys*); not common, scattered; fairly lightly attached to edges of ears and lower jaw and outside ears; on the insectivores, to edges of ears, and abdomen; mixed with other chiggers.

340–420 × 180–350, oval to broad oval; pallid; DS prominent, visible with handlens; sluggish, the honeycombed scutum is easily visible under a low-power stereoscopic microscope.

Mus. 28, 1956.

68. *fletcheri*
Gater 1932, (N)
320-460 × 260-330, broad oval; pallid to creamy; sluggish (those attached to edges to of ears appear desiccated).
69. *neterella*
Traub & Morrow, 1955
As for *G. fletcheri*.
70. *rutila*
Gater, 1932 (N)
320-360 × 210-260, oval or slightly pyriform; pallid; sluggish.
- Gahrlepiea**, subgenus **Schöngastiella** Hirst, after Traub & Evans, 1953
71. *arona*
Traub & Evans, 1953 (N)
Small 360 × 300, broad oval; pallid to creamy; shiny surface.
72. *birella*
Traub & Evans, 1953
330 × 250, broad oval; pallid; sluggish.
73. *hipposideros*
Audy, 1952
UL 185 × 125, subovate; pallid.
74. nr. *helata* Traub & Morrow, 1954
PEL 230 × 180, subovate; pallid to light yellow.
- Gahrlepiea**, subgenus **Walchia** Ewing, after Womersley 1952
75. *brennani*
Womersley 1952 (N)
EL 330 × 250, broad oval; pallid to creamy.
76. b. var. *ventralis*
Womersley 1953 (N)
EL 640 × 370 elongate, oval, marked constriction; pallid to light yellow.
77. *disparunguis*
Oudemans 1929, (N)
380 × 350 elongate oval, slight constriction; light yellow.
78. *enode*
Gater 1932 (N)
Indistinguishable from *pingue* (q.v.).
79. *lewthwaitei*
Gater 1932, (N)
Small 320-460 × 240-330, elongate oval, with constriction; pallid.
80. *pingue*
Gater 1932, (N)
480 × 330, elongate oval; with constriction; pallid.
- On giant-rat (*R. sabanus*) and Tree-shrew (*Tupaia glis*) (6) in forest; fairly highly attached, in groups and scattered, all along edges of ears and outside ears; on *Tupaia*, along edges of ears and on abdomen; mixed with other chiggers on ears, and with other Gahrlepieines on ear-edges and especially under jaw (chin). This and *G. (W.) pingue* are the commonest Gahrlepieines in Malaya. In fairly large numbers in colonies on chins, also among vibrissae on *R. rattus* spp. on Sembilan Islands and Jarak Islands.
- Giant rat in forest, is not common; as for *G. fletcheri*.
- Giant-rat (*R. sabanus*) in forest, rare; as for *fletcheri*.
- Giant-rat (*R. mulleri*) in forest, occasionally, in groups and scattered in ears; local (in large numbers on one occasion with E. "BIS" mixed with other chiggers.
- Giant-rat (*R. boweri*) in forest, rarely; in ears, mixed with other chiggers.
- A Rhinolophid bat (*Hipposideros*), once, attached, to wing, mixed with *T. harrisoni* and *E. lipoxena*.
- Tree-shrew (*Tupaia glis*) and Giant-rat (*R. boweri*) in forest; in ears, mixed with other chiggers.
- Giant-rat (*R. boweri*), occasionally; fairly firmly attached, scattered and in colonies in ears, with other chiggers.
- As for *brennani* but much more abundant and not so firmly attached.
- As for *brennani*, but fairly commonly, in colonies in ears; with other chiggers adjacent.
- As for *pingue*, but rare in Malaya.
- R. exulans* and *R. whiteheadi* in open secondary growth, occasionally in large numbers (16), rare in forest; often unmixed with other spp. on *R. whiteheadi*; as for *pingue*.
- Spiny rat (*R. rajah*) and Giant-rat (*R. sabanus*) in forest, fairly common (1-3), in groups in ears, with other chiggers.

81. *rustica*
Gater 1932, (N) 350-410 × 220-260, oval not constricted; Giant-rat (*R. mulleri*) in forest (I), fairly common, in groups and scattered, in ears, with other chiggers. In large numbers in groups on chin and lip, also scattered among vibrissae, on *Rattus jalorensis* Berhala Island, near Medan, Sumatra.
82. *turmalis*
Gater 1932, (N) Indistinguishable from *rustica*. As for *rustica*, but not yet found on island rat.
83. nr. *rioi* Gunther, 1940 350 × 300, broad oval, slight constriction; Spiny rat (*R. rajah*) in forest; ?local (Ulu Gombak F.R.). light yellow.

Subfamily LEEUWENHOEKIINÆ

Whartonia Ewing, after Wharton & Fuller, 1952

84. "PEN"
Womersley in MS Large, 540 × 400, broad oval, orange to orange-red; inactive; mouthparts deeply buried and body perpendicular. On fruit bat (*Cynopterus (Penthetor)*) (33 on 9 bats) from forest, one collection; scattered, very firmly attached to dorsal and ventral surfaces of wing-membranes; unaccompanied by other chiggers.
85. sp. 'B' Large UL 280 × 230, EL 920 × 730; as A Rhinolophid bat (*Hipposideros*) in forest; as for the above.

Species (TROMBIDIIDS) which may be confused with subfamily APOLONIINÆ

Cockingsia Womersley: according to Southcott (personal communication), this is probably a larval *Neotrombidium*.

86. *tenuipes*
Womersley 1953 Large, UL 260 × 160, EL 720 × 480 sub-ovate; light orange. A giant longicorn beetle from forest; a few hundred collected from near bases of wings on ventral surface; in groups and scattered.

Audyna Womersley: Family Trombidiidae, subfamily Trombellini

87. *thompsoni*
Womersley 1953 (N) Large, 650 × 450, broad ova; creamy white; sluggish. Common Giant Black Scorpion (*Heterometrus longimanus*) from forest, in moderate numbers, lightly attached in groups and scattered mostly under pecten, also on intersegmental membrane.

References

- AUDY, J. R. (1954). Malaysian parasites. IX—Notes on the taxonomy of trombiculid mites, with description of a new subgenus. *Stud. Inst. med. Res., Malaya*, 26 (1953): 123–170.
- AUDY, J. R. (1956a). *Laurentella*, a new subgenus of trombiculid mite, with notes in biology and medical importance. *Bull. Raffles Mus.*, 28, 5–26.
- AUDY, J. R. (1956b). Trombiculid mites infesting birds, reptiles, and arthropods in Malaya, with a taxonomic revision, and descriptions of a new genus, two new subgenera, and six new species. *Bull. Raffles Mus.*, 28, 27–80.
- AUDY, J. R. (1956c). Malayan trombiculid mites. I—*Schoutedenichia vercammeni* n.sp., with a note on the genus. *Bull. Raffles Mus.*, 28, 81–85.
- AUDY, J. R. AND VERCAMMEN-GRANDJEAN, P. H. (1955). Endoparasitism in trombiculid mites. *Nature, Lond.*, 175: 263.
- HARRISON, J. L. (1954). Malaysian Parasites X. Feeding times of trombiculid larvae. *Stud. Inst. med. Res., Malaya*, 26 (1953): 171–183.
- I.M.R. (1955). *Rep. Inst. med. Res., Malaya*, 1954.
- JONES, B. M. (1950). The penetration of the host tissue by the harvest mite, *Trombicula autumnalis* Shaw. *Parasitology*, 40: 247–260.
- LAWRENCE, R. F. (1949). The larval trombiculid mites of South African vetebrates. *Ann. Natal Mus.*, 11: 405–486.
- LOVERIDGE, A. (1925). A mite pocket in the gecko, *Gymnodyctyla lawderanus* Stoliczka. *Proc. Zool. Soc. Lond.*: 1431.
- NUÑEZ, A. R. (1947). Trombidiasis por *Neoschoengastia minézi*, Hoffman. *Gaceta méd. Méx.*, 77: 221–244.
- PARKHURST, H. J. (1937). Trombidiasis (infection with chiggers). *Arch. Dermat. Syph.*, 35: 1011–1036.
- SILVEIRA, C. L. (1949). Parasitose humana provocada por *Apollonia tegipionensis* Torres e Braga [1938. *Bol. Ser. Agr. Ind. Com., Pernambuco*, 16: 1–8.
- SOUTHCOTT, R. V. (1947). Observations on the epidemiology of tsutsugamushi disease in North Queensland. *Med. J. Aust.*, 2: 441–450.
- SOUTHCOTT, R. V. (1954). Description of a new genus and species of larval trombiculid mite from New Guinea. *Trans. R. Soc. S. Aust.*, 77: 98–102.
- TRAUB, R. AND AUDY, J. R. (1954). Malaysian parasites. IV—Species of *Trombicula* (Trombiculidae) from Borneo. *Stud. Inst. med. Res., Malaya*, 26 (1953): 45–76.
- TRAUB, R. AND MORROW, M. L. (1955). A revision of the chiggers of the subgenus *Gahrlepiea* (Acarina: Trombiculidae). *Smithson. Misc. Coll.*, 128 (6), 89 pp.
- WHARTON, G. W. (1946). Observations on *Ascoschoengastia indica* (Hirst, 1915) (Acarinida: Trombiculidae). *Ecol. Monogr.*, 16: 151–184.
- WHARTON, G. W. AND FULLER, H. S. (1952). A manual of the chiggers. The biology, classification, distribution, and importance to man of the larvae of the family Trombiculidae. *Mem. ent. Soc. Wash.*, No. 4, 185 pp.